CLAIMS

We claim:

1. A composition comprising:

    a) an electrode;

    b) at least one nucleoside; and

    c) a conductive oligomer covalently attached to both said electrode and said nucleoside, wherein said conductive oligomer has the formula:

$$-\left(-Y\left(\left(B\right)_g-D\right)_e\right)_n\left(-Y-\right)_m$$

wherein

Y is an aromatic group;

n is an integer from 1 to 50;

g is either 1 or zero;

e is an integer from zero to 10;and

m is zero or 1;

wherein when g is 1, B-D is a conjugated bond; and

wherein when g is zero, e is 1 and D is preferably carbonyl, or a heteroatom moiety, wherein the heteroatom is selected from oxygen, sulfur, nitrogen, silicon or phosphorus.

2. A composition comprising:

    a) an electrode;

    b) at least one nucleoside; and

    c) a conductive oligomer covalently attached to both said electrode and said nucleoside, wherein said conductive oligomer has the formula:

$$-\left(-C-G-C-\right)_n\left(-J-\right)_m$$

wherein

n is an integer from 1 to 50;

m is 0 or 1;

C is carbon;

J is carbonyl or a heteroatom moeity, wherein the heteroatom is selected from the group consisting of oxygen, nitrogen, silicon, phosphorus, sulfur; and

G is a bond selected from alkane, alkene or acetylene.

3. A composition according to claim 1 or 2 wherein said nucleoside is part of a nucleic acid.

4. A composition according to claim 3 further comprising a plurality of conductive oligomers each covalently attached to a nucleic acid.

5. A composition according to claim 4 wherein said nucleic acids are all the same.

6. A composition according to claim 4 wherein at least one of said nucleic acids is different.

7. A composition according to claim 1 or 2 wherein said covalent attachment of said conductive oligomer to said nucleoside is to the ribose or phosphate of said nucleoside.

8. A composition according to claim 1 or 2 wherein said covalent attachment of said conductive oligomer to said nucleoside is to the base of said nucleoside.

9. A composition according to claim 1 or 2 wherein said electrode further comprises at least one passavation agent.

10. A composition according to claim 1 or 2 wherein said electrode further comprises a monolayer of passavation agents.

11. A composition according to claim 10 further comprising a hybridization indicator.

12. A composition comprising:

a) a first electron transfer moiety comprising an electrode;

b) a nucleic acid;

c) a second electron transfer moiety covalently attached to said nucleic acid; and

d) a conductive oligomer covalently attached to both said electrode and said nucleic acid.

13. A composition according to claim 12 wherein said second electron transfer moiety comprises a transition metal complex.

14. A composition according to claim 12 wherein said second electron transfer moiety comprises an organic electron transfer moiety.

15. A composition according to claim 12 wherein said covalent attachment of said second electron transfer moiety is to the ribose-phosphate backbone of said nucleic acid.

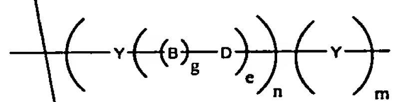
16. A composition according to claim 12 wherein said covalent attachment of said second electron transfer moiety is to a base of said nucleic acid.

17. A composition according to claim 12 wherein said electrode further comprises at least one passavation agent.

18. A composition according to claim 12 wherein said electrode further comprises a monolayer of passavation agents.

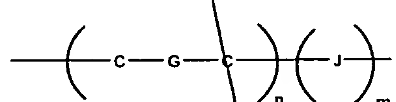
19. A composition according to claim 18 further comprising a hybridization indicator.

20. A composition according to claim 12 wherein said conductive oligomer has the structure:



wherein
Y is an aromatic group;
n is an integer from 1 to 50;
g is either 1 or zero;
e is an integer from zero to 10;and
m is zero or 1;
wherein when g is 1, B-D is a conjugated bond; and
wherein when g is zero, e is 1 and D is preferably carbonyl, or a heteroatom moiety, wherein the heteroatom is selected from oxygen, sulfur, nitrogen, silicon or phosphorus.

21. A composition according to claim 1 wherein said conductive oligomer has the structure:



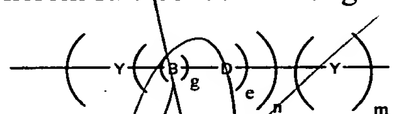
wherein
n is an integer from 1 to 50;
m is 0 or 1;
C is carbon;

J is carbonyl or a heteroatom moeity, wherein the heteroatom is selected from the group consisting of oxygen, nitrogen, silicon, phosphorus, sulfur; and G is a bond selected from alkane, alkene or acetylene.

22. A method of detecting a target sequence in a nucleic acid sample comprising

a) applying an input signal to a hybridization complex comprising:

i) a probe nucleic acid comprising a conductive oligomer covalently attached to a first electron transfer moiety comprising an electrode and to a single stranded nucleic acid capable of hybridizing to said target sequence, said single stranded nucleic acid comprising a covalently attached second electron transfer moiety, wherein said conductive oligomer has the formula:



wherein

Y is an aromatic group;

n is an integer from 1 to 50;

g is either 1 or zero;

e is an integer from zero to 10;and

m is zero or 1;

wherein when g is 1, B-D is a conjugated bond; and

wherein when g is zero, e is 1 and D is preferably carbonyl, or a heteroatom moiety, wherein the heteroatom is selected from oxygen, sulfur, nitrogen, silicon or phosphorus; and

ii) a target nucleic acid hybridized to said probe sequence to form said hybridization complex; and

b) detecting electron transfer between said electrode and said second electron transfer moiety, if present, as an indicator of the present or absence of said target sequence.

23. A method of detecting a target sequence in a nucleic acid sample comprising

a) applying an input signal to a hybridization complex comprising:

i) a probe nucleic acid comprising a conductive oligomer covalently attached to a first electron transfer moiety comprising an electrode and to a single stranded nucleic acid capable of hybridizing to said target sequence, said single stranded nucleic acid comprising a covalently attached second electron transfer moiety, wherein said conductive oligomer has the formula:

$$-\left(C-G-C\right)_n\left(J\right)_m-$$

wherein

n is an integer from 1 to 50;

m is 0 or 1;

C is carbon;

J is carbonyl or a heteroatom moeity, wherein the heteroatom is selected from the group consisting of oxygen, nitrogen, silicon, phosphorus, sulfur; and

G is a bond selected from alkane, alkene or acetylene; and

ii) a target nucleic acid hybridized to said probe sequence to form said hybridization complex; and

b) detecting electron transfer between said electrode and said second electron transfer moiety, if present, as an indicator of the present or absence of said target sequence.

24. A method according to claim 22 or 23 further comprising the step of hybridizing said probe nucleic acid to said target nucleic acid prior to said applying step.

25. A method according to claim 22 or 23 wherein said input signal includes the use of a co-redoxant.

26. A method of detecting a target sequence in a nucleic acid wherein said target sequence comprises a first target domain and a second target domain, said method comprising:

a) hybridizing a first probe nucleic acid to said first target domain, if present, to form a hybridization complex, wherein said first probe nucleic acid comprises:

i) a conductive oligomer covalently attached to a first electron transfer moiety comprising an electrode and to a single stranded nucleic acid capable of hybridizing to said target sequence, wherein said conductive oligomer has the formula:

$$-\left(Y\left(\left(B\right)_g - D\right)_e\right)_n \left(Y\right)_m -$$

wherein

Y is an aromatic group;

n is an integer from 1 to 50;

g is either 1 or zero;

e is an integer from zero to 10;and

m is zero or 1;

wherein when g is 1, B-D is a conjugated bond; and

wherein when g is zero, e is 1 and D is preferably carbonyl, or a heteroatom moiety, wherein the heteroatom is selected from oxygen, sulfur, nitrogen, silicon or phosphorus;

b) hybridizing a second single stranded nucleic acid comprising a covalently attached electron transfer moiety to said second target domain; and

c) detecting electron transfer between said electrode and said second electron transfer moiety, if present, as an indicator of the present or absence of said target sequence.

27. A method of detecting a target sequence in a nucleic acid wherein said target sequence comprises a first target domain and a second target domain, said method comprising:

a) hybridizing a first probe nucleic acid to said first target domain, if present, to form a hybridization complex, wherein said first probe nucleic acid comprises:

i) a conductive oligomer covalently attached to a first electron transfer moiety comprising an electrode and to a single stranded nucleic acid capable of hybridizing to said target sequence, wherein said conductive oligomer has the formula:

$$-\left(C-G-C\right)_n\left(J\right)_m-$$

wherein

n is an integer from 1 to 50;

m is 0 or 1;

C is carbon;

J is carbonyl or a heteroatom moeity, wherein the heteroatom is selected from the group consisting of oxygen, nitrogen, silicon, phosphorus, sulfur; and

G is a bond selected from alkane, alkene or acetylene ; and

b) hybridizing a second single stranded nucleic acid comprising a covalently attached electron transfer moiety to said second target domain; and

c) detecting electron transfer between said electrode and said second electron transfer moiety, if present, as an indicator of the present or absence of said target sequence.

28. A method for attaching a conductive oligomer to a gold electrode comprising

a) adding an ethyl pyridine protecting group to a sulfur atom attached to a first subunit of said conductive oligomer.

29. A method according to claim 28, further comprising adding additional subunits to form said conductive oligomer.

30. A method according to claim 29, further comprising adding at least first nucleoside to said conductive oligomer.

31. A method according to claim 30, further comprising adding additional nucleosides to said first nucleoside to form a nucleic acid.

32. A method according to claim 29 or 31, further comprising attaching said conductive oligomer to said gold electrode.

33. A conductive oligomer with a ethyl-pyridine protected sulfur atom.

34. A method of making a composition according to claim 1, 2 or 12 comprising:

a) providing a conductive oligomer covalently attached to a nucleoside; and

b) attaching said conductive oligomer to said electrode.

35. A method of making a composition according to claim 1, 2 or 12 comprising:

a) attaching a conductive oligomer to an electrode; and

b) attaching at least one nucleotide to said conductive oligomer.

36. A composition comprising a conductive oligomer covalently attached to a nucleoside, wherein said conductive oligomer has the formula:

$$-\left(Y\left((B)_g-D\right)_e\right)_n\left(Y\right)_m-$$

wherein

Y is an aromatic group;

n is an integer from 1 to 50;

g is either 1 or zero;

e is an integer from zero to 10;and

m is zero or 1;

wherein when g is 1, B-D is a conjugated bond; and

wherein when g is zero, e is 1 and D is preferably carbonyl, or a heteroatom moiety, wherein the heteroatom is selected from oxygen, sulfur, nitrogen, silicon or phosphorus.

37. A composition comprising a conductive oligomer covalently attached to a nucleoside, wherein said conductive oligomer has the formula:

$$-\left(C-G-C\right)_n\left(J\right)_m-$$

wherein

n is an integer from 1 to 50;

m is 0 or 1;

C is carbon;

J is carbonyl or a heteroatom moeity, wherein the heteroatom is selected from the group consisting of oxygen, nitrogen, silicon, phosphorus, sulfur; and

G is a bond selected from alkane, alkene or acetylene

38. A composition according to claim 36 or 37 further comprising a hybridization indicator.

39. A composition comprising a conductive oligomer covalently attached to a phosphoramidite nucleoside, wherein said conductive oligomer has the formula:

$$-\left(Y\left(-(B)_g-D\right)_e\right)_n\left(-Y-\right)_m$$

wherein

Y is an aromatic group;

n is an integer from 1 to 50;

g is either 1 or zero;

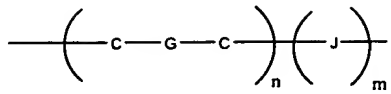
e is an integer from zero to 10;and

m is zero or 1;

wherein when g is 1, B-D is a conjugated bond; and

wherein when g is zero, e is 1 and D is preferably carbonyl, or a heteroatom moiety, wherein the heteroatom is selected from oxygen, sulfur, nitrogen, silicon or phosphorus.

40. A composition comprising a conductive oligomer covalently attached to a phosphoramidite nucleoside, wherein said conductive oligomer has the formula:



wherein

n is an integer from 1 to 50;

m is 0 or 1;

C is carbon;

J is carbonyl or a heteroatom moeity, wherein the heteroatom is selected from the group consisting of oxygen, nitrogen, silicon, phosphorus, sulfur; and

G is a bond selected from alkane, alkene or acetylene

41. A composition comprising a conductive oligomer covalently attached to a CPG-nucleoside.

42. A composition comprising a nucleoside covalently linked to a metallocene.

43. A composition according to claim 42 wherein said metallocene is ferrocene or substituted ferrocene.

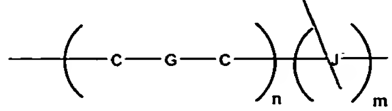
44. A composition according to claim 42 wherein said metallocene is covalently attached to the base of said nucleoside.

45. A composition comprising:

a) an electrode;

b) at least one metallocene; and

c) a conductive oligomer covalently attached to both said electrode and said metallocene, wherein said conductive oligomer has the formula:



wherein

n is an integer from 1 to 50;

m is 0 or 1;

C is carbon;

J is carbonyl or a heteroatom moeity, wherein the heteroatom is selected from the group consisting of oxygen, nitrogen, silicon, phosphorus, sulfur; and

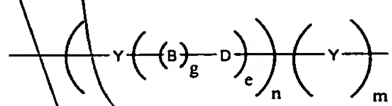
G is a bond selected from alkane, alkene or acetylene

46. A composition comprising:

a) an electrode;

b) at least one metallocene; and

c) a conductive oligomer covalently attached to both said electrode and said metallocene, wherein said conductive oligomer has the formula:



wherein

Y is an aromatic group;

n is an integer from 1 to 50;

g is either 1 or zero;

e is an integer from zero to 10;and

m is zero or 1;

wherein when g is 1, B-D is a conjugated bond; and

wherein when g is zero, e is 1 and D is preferably carbonyl, or a heteroatom moiety, wherein the heteroatom is selected from oxygen, sulfur, nitrogen, silicon or phosphorus.

47. A peptide nucleic acid with at least one chemical substituent covalently attached to the α-carbon of a monomeric subunit.

Sub D1

~~48. A peptide nucleic acid with at least one chemical substituent covalently attached to an internal monomeric subunit of the peptide nucleic acid.~~

~~49. A peptide nucleic acid according to claim 48 said attachment is to a base of said monomeric subunit.~~

~~50. A peptide nucleic acid according to claim 48 said attachment is to the backbone of said monomeric subunit.~~

51. A composition according to claim 48 or 49 wherein said chemical substituent is an electron transfer moiety.

52. A composition according to claim 51 wherein said electron transfer moiety is an electrode.

53. A composition according to claim 51 wherein said electron transfer moiety is a transition metal complex.

54. A composition according to claim 48 wherein said chemical substituent is a label.

Sub C1

55. A composition according to claim 54 wherein said label is a fluoroscent label.

~~56. A composition according to claim 54 wherein said label is a chemiluminescent label.~~

add D1